May 10, 1932. W. E. RUDER 1,857,215

ELECTRICAL INDUCTION APPARATUS

Filed March 5, 1930

Fig. 1.

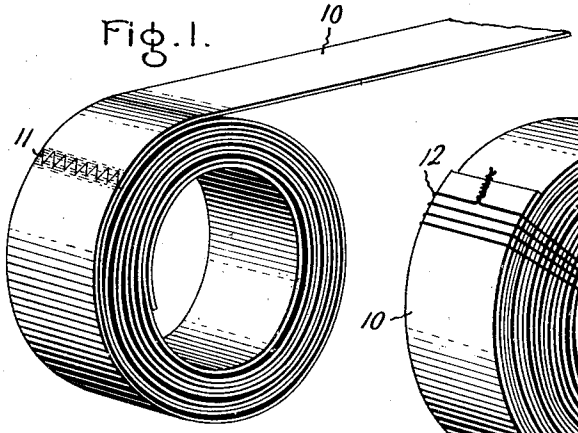


Fig. 2.

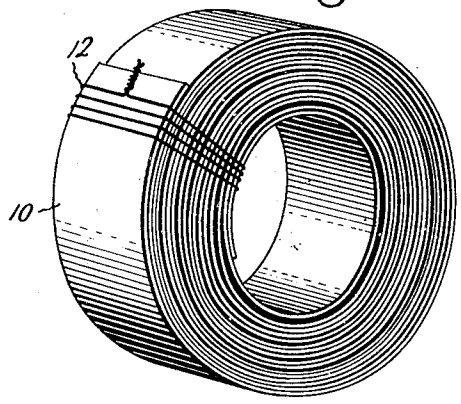


Fig. 3.

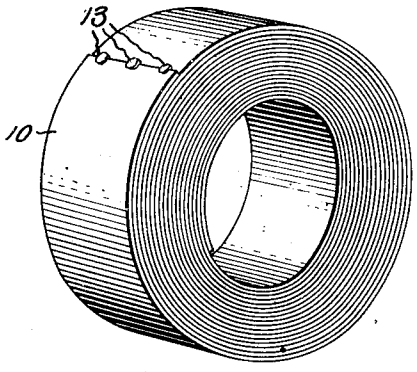
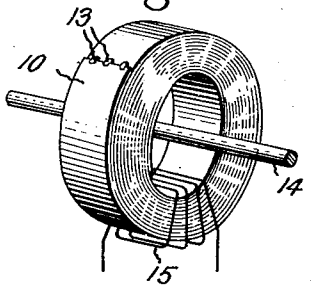


Fig. 4.



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UNITED STATES PATENT OFFICE

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ELECTRICAL INDUCTION APPARATUS

Application filed March 5, 1930. Serial No. 433,484.

My invention relates to electrical induction apparatus and more particularly to an improved method for producing magnetic cores for such apparatus. Where good magnetic efficiency is desired, a magnetic core must be properly annealed to reduce hysteresis losses and a core is generally formed of thin magnetic sheets to facilitate a uniform heating and cooling of the material during the annealing process and thus the production of a uniformly annealed product in the finished core. Unless the core is to operate at a very low magnetic density, the sheets or layers of magnetic material are generally insulated from each other to reduce eddy current losses.

After the magnetic core sheets are annealed, they are very sensitive to stresses, vibration and shock to which they are very apt to be subjected while being assembled and tightened together in forming the core, the result being an impairment of the magnetic characteristics of the material and a loss of at least part of the advantage of the annealing process. The general object of the invention is to provide an improved process for producing an annealed magnetic core whereby the magnetic material of the core is subjected to a minimum of stress, vibration, shock, bending or the like after the annealing process has been completed.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which Fig. 1 shows one form of magnetic core which is partly assembled in accordance with the invention; Fig. 2 shows the complete core in the condition in which it is annealed; Fig. 3 shows the core after it has been annealed and completely assembled, and Fig. 4 shows the completed core on a somewhat reduced scale with its windings as used in a transformer.

Like reference characters indicate similar parts in the different figures of the drawings.

The invention will be explained in connection with what is usually called a wound core although it will be apparent that it is applicable to other forms of core. The wound core shown in the drawings is formed by winding or rolling up a strip or ribbon of thin magnetic sheet material 10 into a roll in the usual way. This strip or ribbon may include a plurality of shorter strips connected together end to end by welded joints 11. The strip 10 is wound loosely as indicated in Figs. 1 and 2 and after the desired length has been wound, it may be secured temporarily and prevented from unwinding by a wrapping of wire 12. This loosely wound or assembled strip preferably has an inner diameter somewhat greater than that desired in the completed core which is shown in Figs. 3 and 4.

After the layers forming the core have been loosely assembled as shown in Fig. 2, the core is annealed, the particular annealing process depending upon the particular magnetic alloy used in the core. In the case of the silicon steel which is now most extensively used, the core may be annealed by heating it to from 800 to 900 degrees centigrade and subsequently cooling it slowly. During this annealing process, the heated gases will penetrate readily between the loosely assembled layers of the core and produce a scale or coating on the surfaces of the layers, this scale serving to insulate adjacent layers from each other and prevent excessive eddy currents in the completed core. As the layers of the core are loosely and only partially assembled, the annealing process will not cause the layers to stick together as would be the case if the layers were assembled tightly together as in the finished core. A somewhat different annealing process is necessary in the case of some of the nickel iron alloys which are sometimes used. One of these alloys, for example, includes about 80% of nickel and 20% of iron and it has been found that the best results are secured by a double anneal. With this alloy, the loosely assembled core may be heated in a hydrogen atmosphere to about 900° centigrade, then cooled slowly, then reheated to about 600° centigrade and then cooled very quickly as by an air blast.

After the loosely or partially assembled core has been properly annealed, the layers of the core are tightened together into the completely assembled condition. In the form of core which has been described, this may be done by holding the inner end of the strip 10

and pulling the outer end around until the layers forming the core are held tightly together as shown in Figs. 3 and 4. The outer end of the strip 10 may be held in place in the completed core by the welds 13. Fig. 3 shows the completed core and Fig. 4 shows the same core on a reduced scale, as it may be used in a transformer, the core being provided with a primary winding 14 and a secondary winding 15.

The annealing process does not form a satisfactory insulating scale or coating on the nickel iron alloy as it does on the silicon steel but this sometimes is not necessary if the core is to operate at a very low flux density. If desired, however, the layers of the nickel iron alloy core may be insulated before assembly by coating their surfaces with an inorganic insulation, such as a suitable insulating material containing mica, which will not be destroyed by the high temperature during the annealing process. If this is done, the nickel iron core may be given the second anneal at the lower or 600° centigrade temperature after the layers of the core have been tightened together. It may also be found desirable in some cases to give the silicon steel core a second anneal at 600° or 650° centigrade after the layers have been tightened together.

The process which has been described avoids the necessity for subjecting a magnetic core to excessive bending and other stresses due to assembly after the core has been properly annealed and thus permits substantially the full benefits of the annealing process to be retained in the finally completed core.

The invention has been explained in connection with a particular form of laminated magnetic core but it will be apparent that its application is not so limited and that various changes may be made without departing from the spirit of the invention or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The process of producing a laminated magnetic core, said process including the steps of loosely assembling the magnetic layers of said core into approximately final core form, annealing said layers while thus loosely assembled, and subsequently tightening said layers together into a final core form.

2. The process of producing a laminated magnetic core, said process including the steps of loosely assembling the magnetic layers of said core, annealing said layers while loosely assembled, subsequently tightening said layers together, and finally annealing said tightened layers at a temperature lower than that of said first anneal.

3. The process of producing a laminated magnetic core, said process including the steps of rolling strip magnetic sheet material into a loose roll, annealing the layers of said roll while loosely assembled, and subsequently tightening said roll to bring its layers tightly together.

4. The process of producing a laminated magnetic core, said process including the steps of coating strip sheet magnetic material with a heat resistant insulating material, rolling said strip into a loose roll, annealing the layers of said roll while loosely assembled, subsequently tightening said roll to bring its layers tightly together, and finally annealing said tightened layers at a temperature lower than that of said first anneal.

In witness whereof I have hereunto set my hand this 4th day of March, 1930.

WILLIAM E. RUDER.